A GENETIC APPROACH FOR TWO-ECHELON CAPACITATED VEHICLE ROUTING AND SCHEDULING PROBLEM WITH TIME WINDOWS(Abstract_要旨)

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論文題目	A GENETIC APPROACH FOR TWO-ECHELON CAPACITATED VEHICLE ROUTING AND SCHEDULING PROBLEM WITH TIME WINDOWS （タイムウィンドウ付き２段階配車配送計画に関する遺伝的アプローチ）		

(Summary of the thesis)

This study proposes a genetic approach algorithm to solve the two echelon capacitated vehicle routing problem with time windows (2E-CVRPTW) which has never been presented with this approach before. It consists of six chapters that can be summarized as follows.

Chapter 1: Introduction

This study is the Two-Echelon Capacitated Vehicle Routing Problem with Time Windows (2E-CVRPTW) in the distribution system. The scope of the delivery model is planning delivering goods from a main depot to the customers through intermediate depots, which are called the satellites on specified time. This problem is motivated by city logistics planning related to legal restriction, environmental impact, confined space, and congested network. Due to these policies, it becomes infeasible to use large vehicles and/or construct a depot facility inside the center of large cities. The objective is the minimization of the total transportation cost of the vehicles involved at both levels. Constraints on the maximum capacity of the vehicles and the intermediate depots are considered, while the timing synchronization of the deliveries in both levels is considered as Two-Echelon Capacitated Vehicle Routing Problem with Time Windows 2E-CVRPTW.

Chapter 2: Literature Review

In this paper, 2E-CVRPTW was decomposed into two phases. The first phase (the second echelon) is solved by using a classical MDVRPTW, in which a genetic algorithm is used for preparing feasible solution and optimal solution. In computational study, the MDVRPTW is proposed to be the model for evaluating in the second echelon, the best known solutions are compared the best known solution found by Polacek et al. (2004) for validating model. The customer is visited by environmental-friendly vehicle exactly once. The second phase (the first echelon) is independently solved by using the similar procedure of the previous phase. Each satellite must be served by large vehicles based at the central depot. This paper presents an algorithm based on philosophy of the GA to solve the model of 2E-CVRPTW. GA has been adopted successfully to a wide variety of NP-hard optimization problems, such as the traveling salesman problem (TSP) and the quadratic assignment problem (Gen and Cheng, 1997; Goldberg, 1989). The success is principally due to its clarity, easy operation, and greater flexibility. These are the major reasons why GA is implemented as an optimization tool in this paper also.

Chapter 3: Hybrid Genetic Algorithms for Two–Echelon Capacitated Vehicle Routing Problem

The 2E-CVRP model is solved using the developed HGA. The grouping procedure of initial solution of the HGAs is developed on an optimization technique in order to efficiently solve the

MDVRP problem in the second echelon. The 2E-CVRP benchmarks were tested for evaluation the algorithm. However, the MDVRP benchmarks proposed for future testing after the improvement of algorithm because they are the large-scale problems. The algorithm shows the effectiveness and efficiency, as based on the 21 instances tested in this study

Chapter 4: A Genetic Approach for Two-Echelon Capacitated Vehicle Routing Problem With Time Windows

The 2E-CVRPTW model is solved using the developed GAs. The crossover procedure for preparing the chromosome representative solution is developed on an optimization technique in order to efficiently solve the MDVRPTW problem in the second echelon. The new 2E-CVRPTW instances set were tested for evaluation the algorithm. Also, MDVRPTW benchmarks proposed for testing after the improvement of GA-2 algorithm. The algorithm shows the effectiveness and efficiency, as based on the 20 instances tested in this study.

Chapter 5: Application for Osaka Network

There are 30 customers, 3 satellites and 1 main depot in Osaka Network for testing the model 2E-CVRPTW. There are 6 scenarios for test results, it seems that the route cost of scenario 1, 2 and 3 that was tested by 2E-CVRPTW model are higher than the scenario 4, 5 and 6 that was tested by classical CVRPTW because this study considered only distribution cost, vehicle fixed cost and depot cost. However, if the study considers total costs include environmental costs and congestion cost, penalty cost the total costs of 2E-CVRPTW model trend to be lower than traditional CVRPTW model.

Chapter 6: Conclusion and Future Research

New model of 2E-CVRP is applied to 2E-CVRPTW. Both stages must be optimized to satisfy transportation choice and customer server within time windows. In this research evaluate the model of freight transport for two layers in Osaka network, where satellite platforms are used to transship goods from vehicles arriving from main depot to smaller, center-city-friendly vehicles. The future research should be include congestion cost, environmental cost penalty for services cost to evaluate efficient model 2E-CVRPTW.

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（論文審査の結果の要旨）

本論文は、都市内物流システムにおいて重要な役割を果たすタイムウィンドウ付き２段階配車配送計画の最適解について、遺伝的アルゴリズムを用いて近似解を求める方法論について明らかにしている。タイムウィンドウ付２段階配車配送計画は、ＮＰ－困難な組み合わせ最適化問題であり、中間物流拠点数および顧客数が増加すると厳密解を求めることが難しくなり、近似解を求めることが多いが、本論文ではハイブリッド型遺伝的アルゴリズムを用いて効率的に近似解を求めている点に新規性が認められる。本論文の概要は以下の３点にまとめられる。

（１） タイムウィンドウ付き２段階配車配送計画は、通常の配車配送計画に比べて、中間物流拠点を介して 2 段階の配車配送計画になっており、さらにタイムウィンドウがあるため、より複雑な問題となっている。この複雑な問題の近似解を効率的に求めるためにハイブリッド型遺伝的アルゴリズムを新たに開発し、中間物流拠点数が 6、顧客数が 280 程度のタイムウィンドウ付２段階配車配送計画の近似解を求めることに成功した。

（２） ここで開発したモデルを仮想の道路ネットワークに適用し、タイムウィンドウ付き多拠点配車配送計画に適用した。その結果、高い精度で近似解を求めることができることを示した。また、タイムウィンドウ付き２段階配車配送計画について、高速で近似解を求めることができることを明らかにした。

（３） さらにこのモデルを大阪の道路ネットワークにおけるタイムウィンドウ付き２段階配車配送計画に適用した。その結果、中間物流拠点の選択、配送経路の最適解を求めることができ、中間物流拠点数、第 1 段階および第 2 段階の車両サイズ等の影響について評価できることを示した。

以上のように、本論文は効率的かつ環境に優しい都市内物流システムを構築するために重要な役割を果たすタイムウィンドウ付き２段階配車配送計画について、効率的に近似解を求める方法論を開発しており、学術面において大きな貢献を行っているとともに実際面においても寄与するところが少なくない。よって、本論文は博士（工学）の学位論文として価値あるものと認める。また、平成 27 年 8 月 21 日、論文内容とそれに関連した事項について試問を行って、申請者が博士後期課程学位取得基準を満たしていることを確認し、合格と認めた。

要旨公開可能日：　平成 27　年　　12 月　　24　日以降